

### REMARKS

Claims 2-11, 13-26, 28-41, 43-57 and 59-80 are pending herein. Claims 3, 20, 35, 51 and 67 have been written in independent form. Accordingly, claims 1, 12, 27, 42 and 58 have been cancelled without prejudice or disclaimer. Claims 2, 4-11, 13-19, 21-26, 28-34, 36-41, 43-50, 52-57, 59-66, 68-70 and 72-75 have been amended for clarification purposes only. Attached hereto as pages 18-30, pursuant to Rule 1.121(c)(1)(ii), is a marked-up version of the amended claims.

New claims 76-80 have been added and correspond to original claims 9, 23, 38, 54 and 73, respectively, written in independent form.

Applicants appreciate the indication that claims 3, 9, 20, 23-25, 35, 38-40, 51, 54-56, 67 and 73-75 would be allowed if rewritten in independent form. Although Applicants do not acquiesce to the art-based rejections discussed below, claims 3, 20, 35, 51 and 67 have been rewritten in independent form. In addition, claims 9, 23, 38, 54 and 73 have been rewritten in independent form as new claims 76-80, respectively.

1. Claims 1, 2, 4-8, 10-19, 21, 22, 26-34, 36, 37, 41-50, 52, 53, 57-66, 68, 69 and 72 were rejected under §102(e) over Kuibira et al. Claims 58, 70 and 71 were rejected under §102(b) over Iwase et al. These rejections are moot in view of rewritten claims 3, 20, 35, 51 and 67, which, as discussed above, were indicated as allowable (if rewritten as submitted above) in the Office Action.

In addition, new claims 76-80, which, as discussed above, correspond to original claims 9, 23, 38, 54 and 73, respectively, rewritten in independent form, should also be allowed because those claims were indicated as allowable (if rewritten as submitted above) in the Office Action.

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Applicants respectfully submit that all pending claims herein are now in condition for allowance. Accordingly, the Examiner is requested to issue a Notice of Allowance for this application in due course.

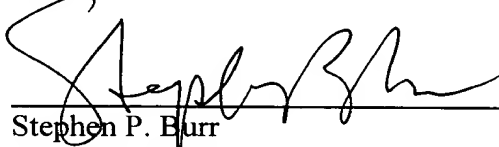
If the Examiner believes that contact with Applicants' attorney would be advantageous toward the disposition of this case, the Examiner is herein requested to call Applicants' attorney at the phone number noted below.

The Commissioner is hereby authorized to charge any additional fees associated with this communication or credit any overpayment to Deposit Account No. 50-1446.

January 9, 2003

Date

Respectfully submitted,

  
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2. (Amended) The material of claim 3+, wherein said samarium-aluminum complex oxide phase contains  $\text{SmAl}_{11}\text{O}_{18}$  phase.
3. (Amended) ~~The~~A material of claim 1~~+~~having a volume resistivity at room temperature of not higher than  $1 \times 10^{13} \Omega\text{-cm}$ , said material being composed of an aluminum nitride sintered body containing samarium in a converted content calculated as samarium oxide of not lower than 0.04 mole percent, said sintered body containing aluminum nitride phase and samarium-aluminum complex oxide phase, wherein said sintered body comprises aluminum nitride grains having a mean diameter of not lower than 3  $\mu\text{m}$ .
4. (Amended) The material of claim 3+, wherein the molar ratio of said converted content of samarium calculated as samarium oxide to an calculated content of aluminum oxide ( $\text{Sm}_2\text{O}_3 / \text{Al}_2\text{O}_3$ ) is 0.05 to 0.5.
5. (Amended) The material of claim 3+, wherein said sintered body has an activation energy of temperature dependency of volume resistivity from room temperature to 300°C of not higher than 0.4 eV.
6. (Amended) The material of claim 3+, wherein said samarium-aluminum complex oxide phase forms a network microstructure.

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**  
**Amended claims**

B

7. (Amended) The material of claim 2, wherein said  $\text{SmAl}_{11}\text{O}_{18}$  phase forms a network microstructure.
8. (Amended) The material of claim 31, wherein said sintered body has a lightness of not higher than N4 measured according to JIS Z8721.
9. (Amended) The material of claim 31, wherein said sintered body contains one or more metal elements selected from the group consisting of metal elements belonging to groups the periodic table IVA, VA, VIA, VIIA and VIIIA of the Periodic Table, and in a content calculated as a metal element of not lower than 0.01 weight percent.
10. (Amended) The material of claim 31, wherein said sintered body contains at least one second rare earth element other than samarium, and wherein the molar ratio of a converted content of said second rare earth element calculated as a rare earth oxide to said converted content of samarium calculated as samarium oxide (~~said converted content of said second rare earth element/said converted content of samarium~~) is not higher than 2.0.
11. (Amended) The material of claim 10, wherein the molar ratio of a total of the converted contents of all of the rare earth elements calculated as rare earth oxides to a calculated content of aluminum oxide (~~said total of converted contents of all the rare earth elements/said content of aluminum oxide~~) is 0.05 to 0.5.

VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended claims

B

13. (Amended) The sintered body of claim 20+2, wherein said  $\text{SmAl}_{11}\text{O}_{18}$  phase forms a network microstructure.

14. (Amended) The sintered body of claim 20+2, wherein said sintered body ~~has~~having a volume resistivity at room temperature of not higher than  $1 \times 10^{13} \Omega \cdot \text{cm}$ .

15. (Amended) The sintered body of claim 20+2, further comprising at least one second rare earth element other than samarium, wherein the molar ratio of a converted content of said second rare earth element calculated as a rare earth oxide to said converted content of samarium calculated as samarium oxide (~~said converted content of said second rare earth element/said converted content of samarium~~) is not higher than 2.0.

16. (Amended) The sintered body of claim 15, wherein the molar ratio of a total of the converted contents of all of the rare earth elements calculated as rare earth oxides to a calculated content of aluminum oxide (~~said total of converted contents of all the rare earth elements/said content of aluminum oxide~~) is 0.05 to 0.5.

17. (Amended) The sintered body of claim 15, wherein said second rare earth element is one or more elements selected from the group consisting of yttrium, lanthanum, cerium, gadolinium, dysprosium, erbium and ytterbium.

18. (Amended) The sintered body of claim 15, further comprising a phase of a complex oxide of said second rare earth element and aluminum.

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**  
**Amended claims**

B

19. (Amended) The sintered body of claim 20+2, further comprising  $\text{SmAlO}_3$  phase.
20. (Amended) ~~The~~An aluminum nitride sintered body ~~of claim 12 comprising~~  
containing samarium in a converted content calculated as samarium oxide of not lower  
than 0.04 mole percent, said sintered body containing aluminum nitride phase and  
 $\text{SmAl}_{11}\text{O}_{18}$  phase, wherein said aluminum nitride sintered body comprises aluminum  
nitride grains with a mean diameter of not lower than 3  $\mu\text{m}$ .
21. (Amended) The sintered body of claim 20+2, wherein the molar ratio of said  
converted content of samarium calculated as samarium oxide to a calculated content of  
aluminum oxide ( $\text{Sm}_2\text{O}_3 / \text{Al}_2\text{O}_3$ ) is 0.05 to 0.5.
22. (Amended) The sintered body of claim 20+2, wherein said sintered body has  
having a lightness of not higher than N4 measured according to JIS Z8721.
23. (Amended) The sintered body of claim 20+2, further comprising one or more  
transition metal elements selected from the group consisting of metal elements belonging  
to groups~~the periodic table~~ IVA, VA, VIA, VIIA and VIIIA of the Periodic Table, and in a  
content calculated as a metal element of not lower than 0.01 weight percent.

VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended claims

B

24. (Amended) The sintered body of claim 23, ~~wherein comprising~~ said transition metal element is present in a content calculated as a metal element of not higher than 1.0 weight percent.

25. (Amended) The sintered body of claim 23, further comprising a crystalline phase of the nitride of said transition metal element.

26. (Amended) The sintered body of claim ~~2012~~, wherein said sintered body has having an activation energy of temperature dependency of volume resistivity from room temperature to 300°C of not higher than 0.4 eV.

28. (Amended) The sintered body of claim ~~3527~~, wherein said sintered body ~~has~~having a volume resistivity at room temperature of not higher than  $1 \times 10^{13} \Omega \cdot \text{cm}$ .

29. (Amended) The sintered body of claim ~~3527~~, wherein said samarium-aluminum complex oxide phase comprises  $\text{SmAl}_{11}\text{O}_{18}$  phase with a network microstructure.

30. (Amended) The sintered body of claim ~~3527~~, further comprising at least one second rare earth element other than samarium, wherein the molar ratio of a converted content of said second rare earth element calculated as a rare earth oxide to said converted content of samarium calculated as samarium oxide (~~said converted content of said second rare earth element/said converted content of samarium~~) is not higher than 2.0.

VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended claims

B

31. (Amended) The sintered body of claim 30, wherein the molar ratio of a total of the converted contents of all of the rare earth elements calculated as rare earth oxides to a calculated content of aluminum oxide (~~said total of converted contents of all the rare earth elements/said content of aluminum oxide~~) is 0.05 to 0.5.

32. (Amended) The sintered body of claim 30, wherein said second rare earth element is one or more elements selected from the group consisting of yttrium, lanthanum, cerium, gadolinium, dysprosium, erbium and ytterbium.

33. (Amended) The sintered body of claim 30, further comprising a phase of a complex oxide of said second rare earth element and aluminum.

34. (Amended) The sintered body of claim ~~35~~27, further comprising  $\text{SmAlO}_3$  phase.

35. (Amended) ~~The~~An aluminum nitride sintered body of claim 27  
~~comprising~~containing samarium in a converted content calculated as samarium oxide of  
not lower than 0.04 mole percent, said sintered body containing aluminum nitride phase  
and samarium-aluminum complex oxide phase with network microstructure, wherein said  
aluminum nitride sintered body comprises aluminum nitride grains with a mean diameter of not lower than 3  $\mu\text{m}$ .

VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended claims

B



36. (Amended) The sintered body of claim 3527, wherein the molar ratio of said converted content of samarium calculated as samarium oxide to a calculated content of aluminum oxide ( $\text{Sm}_2\text{O}_3 / \text{Al}_2\text{O}_3$ ) is 0.05 to 0.5.

37. (Amended) The sintered body of claim 3527, wherein said sintered body ~~has~~having a lightness of not higher than N4 measured according to JIS Z8721.

38. (Amended) The sintered body of claim 3527, further comprising one or more transition metal elements selected from the group consisting of metal elements belonging to ~~groupsthe periodic table~~ IVA, VA, VIA, VIIA and VIIIA of the Periodic Table, and in a content calculated as a metal element of not lower than 0.01 weight percent.

39. (Amended) The sintered body of claim 38, ~~comprising~~wherein said transition metal element is present in a content calculated as a metal element of not higher than 1.0 weight percent.

40. (Amended) The sintered body of claim 38, further comprising a crystalline phase of the nitride of said transition metal element.

41. (Amended) The sintered body of claim 3527, wherein said sintered body has ~~having~~ an activation energy of temperature dependency of volume resistivity from room temperature to 300°C of not higher than 0.4 eV.

VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended claims

B

43. (Amended) The sintered body of claim 5142, wherein the molar ratio of a total of the converted contents of all of the rare earth elements calculated as rare earth oxides to a calculated content of aluminum oxide (~~said total of converted contents of all the rare earth elements/said content of aluminum oxide~~) is 0.05 to 0.5.

44. (Amended) The sintered body of claim 5142, wherein said second rare earth element is one or more elements selected from the group consisting of yttrium, lanthanum, cerium, gadolinium, dysprosium, erbium and ytterbium.

45. (Amended) The sintered body of claim 5142, further comprising a phase of a complex oxide of said second rare earth element and aluminum.

46. (Amended) The sintered body of claim 5142, further comprising aluminum nitride phase and samarium-aluminum complex oxide phase.

47. (Amended) The sintered body of claim 46, wherein said samarium-aluminum complex oxide phase comprises  $\text{SmAl}_{11}\text{O}_{18}$  phase.

48. (Amended) The sintered body of claim 46, wherein said samarium-aluminum complex oxide phase forms a network microstructure.

49. (Amended) The sintered body of claim 5142, wherein said sintered body ~~has~~having a volume resistivity at room temperature of not higher than  $1 \times 10^{13} \Omega \cdot \text{cm}$ .

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**  
**Amended claims**

B

50. (Amended) The sintered body of claim 5142, further comprising  $\text{SmAlO}_3$  phase.

51. (Amended) ~~The~~An aluminum nitride sintered body ~~of claim 42 comprising~~  
comprising samarium in a converted content calculated as samarium oxide of not lower  
than 0.04 mole percent and at least one second rare earth element other than samarium,  
wherein the molar ratio of a converted content of said second rare earth element calculated  
as a rare earth oxide to said converted content of samarium calculated as samarium oxide  
is not higher than 2.0, wherein said aluminum nitride sintered body comprises aluminum  
nitride grains with a mean diameter of not lower than 3  $\mu\text{m}$ .

52. (Amended) The sintered body of claim 5142, wherein the molar ratio of said  
converted content of samarium calculated as samarium oxide to a calculated content of  
aluminum oxide ( $\text{Sm}_2\text{O}_3 / \text{Al}_2\text{O}_3$ ) is 0.05 to 0.5.

53. (Amended) The sintered body of claim 5142, wherein said sintered body has  
having a lightness of not higher than N4 measured according to JIS Z8721.

54. (Amended) The sintered body of claim 5142, further comprising one or more  
transition metal elements selected from the group consisting of metal elements belonging  
to group~~the periodic table~~ IVA, VA, VIA, VIIA and VIIIA of the Periodic Table, and in a  
content calculated as a metal element of not lower than 0.01 weight percent.

VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended claims

B

55. (Amended) The sintered body of claim 54, ~~comprising~~wherein said transition metal element is present in a content calculated as a metal element of not higher than 1.0 weight percent.

56. (Amended) The sintered body of claim 54, further comprising a crystalline phase of the nitride of said transition metal element.

57. (Amended) The sintered body of claim 5142, wherein said sintered body has having an activation energy of temperature dependency of volume resistivity from room temperature to 300°C of not higher than 0.4 eV.

59. (Amended) The member of claim 6758, wherein said sintered body has a volume resistivity at room temperature of not lower than  $1 \times 10^8 \Omega \cdot \text{cm}$  and not higher than  $1 \times 10^{13} \Omega \cdot \text{cm}$ .

60. (Amended) The member of claim 6758, wherein said sintered body contains samarium in a converted content calculated as samarium oxide of not lower than 0.04 mole percent and aluminum nitride phase and samarium-aluminum complex oxide phase.

61. (Amended) The member of claim 60, wherein said samarium-aluminum complex oxide phase comprises a  $\text{SmAl}_{11}\text{O}_{18}$  phase.

VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended claims

B

62. (Amended) The member of claim 60, wherein said samarium-aluminum complex oxide phase forms a network microstructure.

63. (Amended) The member of claim ~~67~~58, wherein said aluminum nitride sintered body contains samarium in a converted content calculated as samarium oxide of not lower than 0.04 mole percent and at least one second rare earth element other than samarium, and wherein the molar ratio of a converted content of said second rare earth element calculated as a rare earth oxide to said converted content of samarium calculated as samarium oxide (~~said converted content of said second rare earth element/said converted content of samarium~~) is not higher than 2.0.

64. (Amended) The member of claim 63, wherein the molar ratio of a total of the converted contents of all of the rare earth elements calculated as rare earth oxides to a calculated content of aluminum oxide (~~said total of converted contents of all the rare earth elements/said content of aluminum oxide~~) is 0.05 to 0.5.

65. (Amended) The member of claim 63, wherein said second rare earth element is one or more elements selected from the group consisting of yttrium, lanthanum, cerium, gadolinium, dysprosium, erbium and ytterbium.

66. (Amended) The member of claim 63, further comprising-containing a crystalline phase of a complex oxide of said second rare earth element and aluminum.

VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended claims

B

67. (Amended) ~~The~~A member of ~~claim 58, wherein~~used for the production of semiconductors, wherein at least a part of said member is made of an aluminum nitride sintered body containing samarium, and said sintered body contains aluminum nitride grains with a mean diameter of not lower than 3  $\mu\text{m}$ .

68. (Amended) The member of claim ~~67~~58, wherein the molar ratio of said converted content of samarium calculated as samarium oxide to a calculated content of aluminum oxide ( $\text{Sm}_2\text{O}_3 / \text{Al}_2\text{O}_3$ ) is 0.05 to 0.5.

69. (Amended) The member of claim ~~67~~58, wherein said sintered body has an activation energy of temperature dependency of volume resistivity from room temperature to 300°C of not higher than 0.4 eV.

70. (Amended) The member of claim ~~67~~58, further comprising a substrate made of said aluminum nitride sintered body and a metal member embedded in said substrate.

72. (Amended) The member of claim ~~67~~58, wherein said sintered body has a lightness of not higher than N4 measured according to JIS Z8721.

73. (Amended) The member of claim ~~67~~58, wherein said sintered body contains one or more transition metal elements selected from the group consisting of metal elements belonging to ~~group~~the periodic table IVA, VA, VIA, VIIA and VIIIA of the Periodic

VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended claims

B

Table, and in a content calculated as a metal element of not lower than 0.01 weight percent.

74. (Amended) The member of claim 73, wherein said sintered body contains said transition metal element in a content calculated as a metal element of not higher than 1.0 weight percent.

75. (Amended) The member of claim 73, wherein said sintered body contains a crystalline phase of the nitride of said transition metal element.

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**  
**Amended claims**

B

**The paragraph beginning on page 1, line 24 has been amended as follows:**

Japanese patent publication (Kokoku) with a publication number 46032/1988 discloses a process for producing an aluminum nitride sintered body. According to the claim 1, aluminum nitride powder containing 1 weight percent of oxygen is mixed with 0.01 to 15 weight percent of the oxide of a metal element selected among yttrium, lanthanum, praseodymium, niobium, samarium, gadolinium and dysprosium to obtain mixed powder. The powder is then shaped and sintered to obtain an aluminum nitride sintered body having a high thermal conductivity and containing 0.01 to 20 weight percent of oxygen. According to "example 1" in the publication, aluminum nitride powder (with a mean particle diameter of 1  $\mu\text{m}$ ) containing 1 weight percent of oxygen is mixed with 3 weight percent of samarium oxide to obtain mixed powder. The powder is then subjected to hot press at a pressure of 300  $\text{kg/cm}^2$  and a temperature of 1800  $^{\circ}\text{C}$  for 1 hour to obtain a sintered body with a heat conductivity of 121  $\text{W}\cdot\text{m/k}$  at room temperature.

**The heading on page 6, line 17 has been amended as follows:**

~~Preferred embodiments~~ Detailed Description of the Invention

**The paragraph beginning on page 7, line 27 has been amended as follows:**

The inventors have further studied the contents of aluminum oxide and samarium oxide and found the following relationship. That is, the volume resistivity of the sintered body at room temperature may be further reduced, by controlling the molar ratio of a converted content of samarium calculated as samarium oxide to a calculated content of aluminum oxide ( $\text{Sm}_2\text{O}_3 / \text{Al}_2\text{O}_3$ ) within 0.05 to 0.5. The content of  $\text{Sm}_2\text{O}_3$  may be

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**  
**Amended specification paragraphs**

B



calculated by converting the content of samarium element in the sintered body to the content of  $\text{Sm}_2\text{O}_3$ . The content of  $\text{Al}_2\text{O}_3$  may be calculated by the following steps. First, total content of oxygen atoms in the sintered body is obtained. Second, the content of oxygen in  $\text{Sm}_2\text{O}_3$  is subtracted from the total content of oxygen to obtain the content of remaining oxygen. The content of  $\text{Al}_2\text{O}_3$  is calculated under the provision that all the remaining oxygen atoms are bonded with Al atoms to form  $\text{Al}_2\text{O}_3$  molecules.

**The paragraph beginning on page 9, line 24 has been amended as follows:**

It is also possible to give a color of a low lightness (blackish color) to the surface of the aluminum nitride sintered body, by adding one or more transition metal elements selected from the group consisting of metal elements belonging to the periodic table groups IVA, VA, VIA, VIIA and VIIIA. Such color with a low lightness may be useful for reducing the color irregularity on the surface. Although such added transition metal element may be effective for reducing the lightness of the surface, the effects of the transition metal elements on the low volume resistivity and low activation energy of temperature dependency of volume resistivity have not been confirmed.

**The paragraph beginning on page 10, line 27 has been amended as follows:**

The aluminum nitride sintered body may preferably have a lightness of not higher than N4 defined in “JIS Z 8721” and thereby generate a high quantity of heat radiation, thus providing excellent heating property. The sintered body may be useful for a substrate constituting a heating member such as a ceramic heater and susceptor.

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**  
**Amended specification paragraphs**

B

**The paragraph beginning on page 11, line 5 has been amended as follows:**

The lightness will be described below. The surface color of a substance may be represented by three properties of color perception: hue, lightness and chroma. The lightness is a property for representing visual perception judging the reflectance of the surface of a substance. The representations of the three properties are defined in "JIS Z 8721". The representation of lightness will be briefly described. The lightness "V" is defined based on achromatic colors. The lightnesses of ideal black and ideal white are defined as "0" and "10", respectively. Achromatic colors between the ideal black and ideal white are divided into 10 categories and represented as symbols from "N0" to "N10". The categories are divided so that each category has a same rate or span in terms of visual perception of lightness. When actually measuring the lightness of an aluminum nitride sintered body, the surface color of the body is compared with standard color samples corresponding with "N0" to "N10" to determine the lightness of the body. The lightness is determined to the first decimal point, whose value is selected from "0" and "5".

**The paragraph beginning on page 12, line 6 has been amended as follows:**

However, when the content of the second rare earth element is too large, the content of  $\text{SmAlO}_3$  is increased and the content of  $\text{SmAl}_{11}\text{O}_{18}$  is decreased in the intergranular phase, so that the formation of the network microstructure may be interrupted. This tends to cause the increase of volume resistivity and activation energy of temperature dependency of volume resistivity. For preventing the problems, the molar ratio of a converted content of the second rare earth element "Re" calculated as rare earth oxide " $\text{Re}_2\text{O}_3$ " to a converted content of samarium calculated as samarium oxide

**VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended specification paragraphs**

B

( $\text{Re}_2\text{O}_3$  /  $\text{Sm}_2\text{O}_3$ ) may preferably be not higher than 2.0. The ratio may more preferably be not higher than 1.5 and most preferably be not higher than 1.2.

**The paragraph beginning on page 12, line 18 has been amended as follows:**

For attaining the effect of the fine control of volume resistivity by the addition of the second rare earth element, the molar ratio of a converted content of the element “Re” calculated as “ $\text{Re}_2\text{O}_3$ ” to a converted content of samarium calculated as the oxide ( $\text{Re}_2\text{O}_3$  /  $\text{Sm}_2\text{O}_3$ ) may preferably be not lower than 0.05 and more preferably be not lower than 0.1.

**The paragraph beginning on page 12, line 24 has been amended as follows:**

When adding the second rare earth element, the crystalline phase of the inventive sintered body is mainly composed of AlN phase and the phase of aluminum-samarium complex oxide. The complex oxide phase typically contains  $\text{SmAl}_{11}\text{O}_{18}$  phase and  $\text{SmAlO}_3$  phase. It is considered that the second rare earth elements are mainly dissolved into the complex oxide phase. However, phase of complex oxide of the second rare earth element “Re” and aluminum, such as  $\text{Re}_3\text{Al}_5\text{O}_{12}$  phase, is formed in some compositions.

**The paragraph beginning on page 13, line 11 has been amended as follows:**

The second rare earth element other than samarium refers to the following sixteen elements: scandium, yttrium, lanthanum, cerium, praseodymium, neodymium,

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**  
**Amended specification paragraphs**

B

promethium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium.

**The paragraph beginning on page 13, line 27 has been amended as follows:**

In a preferred embodiment, the molar ratio of total of converted contents of all the rare earth elements "Re" (including samarium) calculated as the oxides to a calculated content of aluminum oxide ( $\text{Re}_2\text{O}_3 / \text{Al}_2\text{O}_3$ ) is 0.05 to 0.5. It is thereby possible to considerably reduce the volume resistivity of the sintered body at room temperature. The ratio ( $\text{Re}_2\text{O}_3 / \text{Al}_2\text{O}_3$ ) may preferably be not lower than 0.1 and more preferably be not higher than 0.4.

**The paragraph beginning on page 18, line 3 has been amended as follows:**

4 types of AlN raw powdery materials were used, including 2 kinds "A" and "B" of commercial materials produced by reduction nitriding and 2 kinds of materials "C" and "D" produced by gaseous phase synthesis. "A" contains 0.97 weight percent of oxygen, "B" contains 0.87 weight percent of oxygen, "C" contains 0.44 weight percent of oxygen and "D" contains 1.20 weight percent of oxygen. A commercial powder of samarium oxide with a purity of not lower than 99.9 percent and a mean particle diameter of 1.1  $\mu\text{m}$  was used.

**The paragraph beginning on page 18, line 10 has been amended as follows:**

Each powder was weighed as shown in tables 1 and 4. Each weighed powder was then subjected to wet blending using isopropyl alcohol as a solvent, a nylon pot and nylon

**VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended specification paragraphs**

B

media for 4 hours to obtain slurry. After the blending, the slurry was collected and dried at 110°C. The thus dried powder was then subjected to heat treatment in an atmosphere at 450°C for 5 hours to remove carbon content contaminated during the wet blending to produce raw mixed powder. In the columns of “ratio (mol %)” of the mixed powder, the ratios of AlN powder and Sm<sub>2</sub>O<sub>3</sub> powder were calculated ignoring the content of impurities.

**The paragraph beginning on page 20, line 4 has been amended as follows:**

It is determined by using a rotating anode type X-ray diffraction system “RINT” supplied by “Rigaku Denki” under the following condition: CuK $\alpha$ , 50 kV, 300 mA, and  $2\theta=20$  to  $70^\circ$ .

**The paragraph beginning on page 20, line 8 has been amended as follows:**

It is measured by a method according to “JIS C 2141” from room temperature to about 400°C under vacuum. The test sample has the following parts: a plate with 50 mm $\times$ 50mm $\times$ 1mm; a main electrode with a diameter of 20 mm; a guard electrode with an inner diameter of 30 mm and outer diameter of 40 mm; and an applying electrode with a diameter of 45 mm. The electrodes are formed of silver. 500 V/mm of voltage is applied and a current is read one minute after the application of voltage so that the volume resistivity is calculated.

**VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended specification paragraphs**

B

**The paragraph beginning on page 20, line 27 has been amended as follows:**

A four-point bending strength at room temperature is measured according to “JIS R1601”.

**The paragraph beginning on page 21, line 10 has been amended as follows:**

The above AlN powder “A” was used. 0.235 mole percent of  $\text{Sm}_2\text{O}_3$  was added to the AlN powder to obtain raw mixed powder, which was sintered at  $1800^\circ\text{C}$  to provide a dense body with a density of  $3.30 \text{ g/cm}^3$  and an open porosity of 0.04 percent.

**The paragraph beginning on page 21, line 17 has been amended as follows:**

The volume resistivity was  $6 \times 10^{10} \Omega\cdot\text{cm}$  at room temperature ( $25^\circ\text{C}$ ) and  $1 \times 10^8 \Omega\cdot\text{cm}$  at  $300^\circ\text{C}$ . In table 2, “ $6 \times 10^{10}$ ” was represented as “6E+10”. The same method of representation will be applied in the following tables.

**The paragraph beginning on page 25, line 14 has been amended as follows:**

As shown in Figs. 4 and 5, Sm phase was recognized in the sintered body according to the example 1 and comparative example 3. In the Sm phase, Sm atoms were distributed between AlN matrix forming spherical entities (designated as “spherical portions”). Further in the sintered body of the example 1, characteristic elongate portions were recognized. In the elongate portions, the content of Sm element was lower compared with that in the spherical portion. In other words, the spherical portions were brighter than the elongate portions. The elongate portions were distributed within the intergranular phase between AlN grains to form a kind of network-like entities. The substances

**VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended specification paragraphs**

B

constituting the spherical and elongate portions were identified by comparing the photographs by EPMA and the results of the above X-ray diffraction measurement. Consequently, it is assumed that the spherical portions with a higher content of Sm atoms are composed of  $\text{SmAlO}_3$  and the elongate portions forming network with a lower content of Sm atoms are composed of  $\text{SmAl}_{11}\text{O}_{18}$ . It is speculated that the volume resistivity of the sintered body is reduced by the presence of  $\text{SmAl}_{11}\text{O}_{18}$  phase in the intergranular layers between AlN grains, forming conductive pass.

**The paragraph beginning on page 26, line 7 has been amended as follows:**

When the AlN powder “B”, “C” or “D” was used, substantially same properties as the example 1 were obtained within a certain range of the content of  $\text{Sm}_2\text{O}_3$ . Particularly when the AlN powder “C” with a low oxygen content was used, the content of  $\text{Sm}_2\text{O}_3$  required for attaining a low volume resistivity shifted to a lower content range. On the other hand, when the AlN powder “D” with a high oxygen content was used, the content of  $\text{Sm}_2\text{O}_3$  required for attaining a low volume resistivity shifted to a higher content range. The volume resistivity of the aluminum nitride sintered body may be controlled by adjusting the molar ratio of the contents of  $\text{Sm}_2\text{O}_3$  to  $\text{Al}_2\text{O}_3$ , in addition to the content of  $\text{Sm}_2\text{O}_3$  (molar ratio) alone.

**The paragraph beginning on page 31, line 13 has been amended as follows:**

The current distribution analytic images of the sintered body according to the example 7, taken by an atomic force microscope (AFM), were shown in Figs. 8 and 9.

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**  
**Amended specification paragraphs**

B

The test sample has a shape of a plate with dimensions of 2 mm × 3 mm × 0.2 mm. The face of the sample for current distribution analysis was polished. The analysis was carried out using a model “SPM stage D 3100” (probe type “DDESP”) supplied by Digital Instruments. The measurement was performed on contact AFM current measurement mode. A direct current (DC) bias was applied on the lower face of the sample and the current distribution on the polished face was measured using the probe.

**The paragraph beginning on page 32, line 15 has been amended as follows:**

In the example 7,  $\text{SmAl}_{11}\text{O}_{18}$  phase is continuous along the intergranular phase of AlN grains of the sintered body (along the outer surfaces of the grains), forming a kind of network microstructure. Apparently, if another phase made of a samarium-aluminum complex oxide other than  $\text{SmAl}_{11}\text{O}_{18}$  forms continuous network microstructure, such microstructure contributes to the reduction of volume resistivity of an aluminum nitride sintered body. Such complex oxide includes  $(\text{Sm}, \text{A})(\text{Al}, \text{B})_{11}(\text{O}, \text{C})_{18}$ . “A” represents an element replacing a part of samarium site, “B” is an element replacing a part of aluminum site, and “C” is an element replacing a part of oxygen site. “A”, “B” and “C” include the following elements.

**The paragraph beginning on page 32, line 25 has been amended as follows:**

“A” includes the second rare earth element other than samarium as described above. “B” includes Mg, Ga, Ti, Fe, Co, V, Cr, Ni or the like. “C” includes N or the like.

**VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended specification paragraphs**

B



**The paragraph beginning on page 33, line 3 has been amended as follows:**

Aluminum nitride sintered bodies were produced substantially same as the experiment <sup>22</sup>"A". The formulation of raw material in the examples 15 to 19 was same as that in the example 7. The formulation of raw material in the examples 20 and 21 was same as that in the example 12. TiO<sub>2</sub> (a purity of 99.9 percent: a mean particle diameter of not higher than 1  $\mu$ m) was added to the raw material of each example in a predetermined amount shown in table 6 as a blackening agent. The manufacturing and evaluating processes were same as those in the example 7.

**The paragraph beginning on page 33, line 11 has been amended as follows:**

Table 6 shows the formulation of raw material, sintering conditions, results of chemical analysis of elements in the sintered body, and the converted contents of metal elements in each sintered body according to each example. Table 7 shows the properties of each of the resulting sintered bodies. In table 6, an amount of added TiO<sub>2</sub> is represented as an amount (mole percent) calculated on the provision that total of amounts of AlN, Sm<sub>2</sub>O<sub>3</sub> and Al<sub>2</sub>O<sub>3</sub> is 100 mole percent. The content of Ti in each sintered body was determined by an inductively coupling plasma (ICP) spectrometry. The lightness of the surface color was determined according to <sup>22</sup>"JIS Z 8721".

**The paragraph beginning on page 36, line 27 has been amended as follows:**

(Experiment <sup>22</sup>"D": Examples 22 to 33 and comparative examples 9 and 10: The effects of the addition of a second rare earth element other than samarium)

**VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended specification paragraphs**

B

**The paragraph beginning on page 37, line 3 has been amended as follows:**

Commercial powder of  $Y_2O_3$ ,  $La_2O_3$ ,  $CeO_2$ ,  $Gd_2O_3$ ,  $Dy_2O_3$ ,  $Er_2O_3$ , or  $Yb_2O_3$  (each powder has a purity of not lower than 99.9 percent and a mean particle diameter of not higher than 2  $\mu m$ ) was used as a source of second rare earth element. The above reduction nitriding powder "B" was used as AlN powder.  $Sm_2O_3$  powder used was the same as that in the experiment "A".

**The paragraph beginning on page 37, line 8 has been amended as follows:**

Each powder was weighed according to the compositions shown in Table 8, and then each raw mixed powder was produced, shaped and sintered to obtain each sintered body, which was then evaluated, according to the same procedure in the experiment "A". The molar ratios of AlN powder,  $Sm_2O_3$  powder and powder of the second rare earth oxide were calculated ignoring the content of impurities. Table 8 also shows each sintering temperature.

**The paragraph beginning on page 40, line 1 has been amended as follows:**

In the column "compositions of sintered body", the contents of  $Sm_2O_3$ , the rare earth oxide and  $Al_2O_3$  were calculated based on the contents obtained by chemical analysis of Sm, rare earth element and oxygen, according to the following procedure.

**The paragraph beginning on page 40, line 20 has been amended as follows:**

The contents of  $Sm_2O_3$ , the oxide of the second rare earth element and  $Al_2O_3$  calculated as described above were subtracted from 100 (mole percent) to provide the

**VERSION WITH MARKINGS TO SHOW CHANGES MADE  
Amended specification paragraphs**

B

content of AlN. Each content of each component was represented using "mole percent" as a unit. This calculation is performed under the provision that total of the contents of AlN, Sm<sub>2</sub>O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub> and the oxide of the second rare earth element is 100 mole percent.

**The paragraph beginning on page 44, line 19 has been amended as follows:**

Fig. 12 shows X-ray diffraction profiles of the sintered bodies according to the examples 24 and 25 and comparative examples 9 and 10. In the examples 24 and 25 and comparative examples 9 and 10, as shown in table 8, the amount of Sm<sub>2</sub>O<sub>3</sub> was maintained constantly and the amount of CeO<sub>2</sub> is increased stepwise when formulating the raw mixed powder. In Fig. 12, the diagrams of the examples 24, 25, and comparative examples 9, 10 were arranged vertically in series. Peak "C" is a representative peak of SmAl<sub>11</sub>O<sub>18</sub> phase and peak "D" is a representative peak of SmAlO<sub>3</sub> phase. CuK $\alpha$  ray and current of 50 kV and 300 mA were used.

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**  
**Amended specification paragraphs**

B

Appl'n No.: 09/982,484

### Abstract

A material with a low volume resistivity at room temperature composed of an aluminum nitride sintered body is provided. The sintered body contains samarium in a converted content calculated as samarium oxide of not lower than 0.04 mole percent,<sub>5</sub> and ~~the~~ The sintered body contains an aluminum nitride phase and a samarium-aluminum complex oxide phase. The samarium-aluminum complex oxide phase forms intergranular layers with a low resistivity along the intergranular phase between aluminum nitride grains.

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**

**Amended abstract**

B

**In the Abstract:**

✓ Attached hereto as page 56, pursuant to Rule 1.121(b)(1)(ii) is a clean version of the Abstract incorporating the changes being made thereto. Please replace the original Abstract with the new Abstract attached as page 56. Attached hereto as page 57, pursuant to Rule 1.121(b)(1)(iii), is a marked-up version of the Abstract showing changes being made thereto.

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